Chapter 41
Mobile + Cloud:
Opportunities and Challenges

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ABSTRACT

A mobile phones provides portability and personalized computing with ubiquitous connectivity. This combination makes them an ideal choice to use for various applications of personal use. The portability of mobile devices is the most important and useful feature of mobile devices. However, portability is achieved at the high cost of limited power and computation ability of the mobile device. Cloud computing fulfills the need of providing more computation power to complete the tasks that cannot be done on a mobile platform. The cloud provides an always available platform and do not have typical limitations, e.g. limited battery and computation power, of mobile platforms. Therefore combining cloud computing with mobile provides us best of both worlds i.e. we have a computing platform available for us all the time which we move, and yet we can access services and perform tasks that require high-power computation.

INTRODUCTION

In the last few years, there has been a remarkable spread of mobile technologies in developed as well as in developing countries. The penetration of mobile technologies is now far more than that of the regular internet and land-line telephones. According to the 2014 report of Telecom Regulatory Authority of India (TRAI), there are 943.9 million wireless telephones with a teledensity of ~75% and share of ~97% of total telephones in India. The TRAI report also mentions that while wired internet covers around 10% of the population (mostly in metro cities), the mobile internet reaches deep in every demography and more importantly almost everyone has access to a mobile device either through their personal phone or shared phone of a family member. It makes mobile phone the most ubiquitous computing platform.

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Mobile phone provides portability and personalized computing with ubiquitous connectivity. This combination makes them an ideal choice for various applications of personal use, e.g. to know about transportation medium, healthcare advice, education, or entertainment. The portability of mobile devices is the most important and useful feature of mobile devices. However, portability is achieved at the high cost of limited power and computation ability of the mobile device.

For augmenting the computation ability of a mobile device, various solutions have been proposed which include the use of standard techniques for example Remote Procedure Calls (RPC). A survey by Satyanarayan (2010) provides a good overview of such techniques. An interesting approach, namely cyber-foraging, has been proposed by Balan et al. (2002, 2007). The cyber-foraging approach provides a novel insight of using existing nearby machines at one hop distance, called s*urrogates*, for offloading the computation. Most importantly, they advocate that the surrogates need not be trusted or managed. They propose the system to implement cyber foraging and modify existing applications to make use of cyber foraging (Balan, Gergle, Satyanarayanan, & Herbsleb, 2007). The cyber foraging approach stands out from other proposed solutions in multiple aspects: it proposed the use of existing surrounding machines instead of deploying new infrastructure; the machines need not be managed or trustworthy; use of surrogates improves the experience of the user of the application, but, the absence of surrogates does not stop the execution of the application. The proposed solution exploits the fact that surrogates are only a single hop away, and a direct link can be established with thus reducing latency. In later work (Satyanarayanan, Bahl, Cáceres, & Davies, 2009), the authors propose the use of VM based *cloudlets* to enable cyber foraging. VM based cloudlets solve the problem of misconfiguration and allow a smooth transitioning of application code execution from the mobile device to cloudlet and vice-versa. The cyber-foraging approach has been used for augmenting mobile capabilities with fixed infrastructure in different resource-constrained environments (Flinn, 2012) (Lewis, Echeverría, Simanta, Bradshaw, & Root, 2014). Though, the cyber-foraging approach advocates and promotes the use of existing unmanaged infrastructure, however, the complexities associated with such a set-up cannot easily be overcome.

Therefore, Cloud computing has emerged as the most popular alternative to providing unlimited computing ability to a mobile device while leveraging the ubiquitous connectivity that a mobile device offers. Cloud computing fulfills the need of providing more computation power to complete the tasks that cannot be done on a mobile platform. The cloud provides an always available platform and does not have limitations, e.g. limited battery and computation power, typical of the mobile platform. Moreover, the cloud infrastructure is managed and trustworthy, thus, it frees the user of the mobile device from the task of managing trust and handle the uncertainty of interacting with an unmanaged device. Therefore combining cloud computing with mobile provides us best of both worlds i.e. we have a computing platform available for us while on the move, and yet we can access services and perform tasks that require high-power computation.

Mobile Cloud Computing platforms, which harness the power of cloud computing with mobile devices, are being extensively used in various domains such as healthcare, transportation, energy monitoring, education, etc. to provide novel solutions for existing research and social problems. Use of cloud platform has given rise to novel research areas such as participatory sensing, crowd-sourcing, etc. which explore how cloud systems can be used with mobile systems to create better systems. Moreover use of cloud for storage and computation frees the mobile device from these requirements and allows mobile to do other functions which a cloud cannot perform, for example, use of onboard sensors to detect vital parameters that can be used, by the cloud, in providing a personalized environment to the user or in detecting a pattern or a context necessary for the new generation of smart applications e.g. using ac-